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Patentanmeldung Nr. Patent application No. Demande de brevet n°

02015461.3

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A device for the heating of a liquid

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A device for the heating of a liquid.

The present invention concerns a device for the heating of a liquid in a beverage machine.

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It is already known to have a liquid heating module for use in a hot beverage machine. The patent application WO 01/54551 in the name of the assignee concerns a liquid heating module for use in a hot beverage machine, which comprises a hollow tube of metallic material, a cylindrical insert, disposed inside the hollow tube, at least one electrical resistor on a first part of the outside of the tube for preheating liquid and at least one other electrical resistor on a second part of the outside of the tube for temperature adjustment of the liquid flowing through the tube. The problem with this solution is that the resistors work in parallel and therefore there is a high demand of energy, because said resistors add their energy requirements, which can reach high level, when a high increase of the liquid temperature is required.

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The objective of the present invention is to have also a device for the heating of a liquid in a hot beverage machine, wherein the variation of demand of power is less important, wherein the target temperature of the liquid is reached quickly and wherein there is a fine adjustment of the liquid temperature at the moment of the arrival of said liquid on an extraction head or other.

The present invention concerns a device for the heating of a liquid in a beverage machine comprising

- at least one set of at least two resistors, wherein said resistors are electrically linked together so as to use one resistor of each set individually or in serial with one or more of the resistors of the same set,

- at least one individual resistor and at least one set of at least two resistors, wherein said resistors are electrically linked together so as to use the first resistor of a set individually or in serial with one or more of the following resistors of the same set,
5 said resistors transferring the maximum of energy to the flow of liquid and allowing a finer control of the liquid temperature.

10 As clearly mentioned above, there are two embodiments to the present invention.

The liquid which has to be heated in the device of the invention is not critical and can be any type of liquid or fluid. Preferably, the liquid heated is water, for example for preparing tea, coffee or other types of beverages. It is also possible to heat milk, for example for the preparation of cocoa beverages. The heater can also be used for heating pumpable fluid or paste, like soups and suces. The generation of steam can also be considered, for example for heating directly water in a cup or for foaming milk. The use of the device of the invention can be considered for small machines, like coffee machines or bigger machines, like vending machines.
25

The important feature of the invention is that the device is used with resistors which are in serial relationship : this is important, because in the case of at least three resistors, the power P used is not always the addition of the power of the single resistors, but, for example, in the case of n resistors in serial
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$$P_{\text{total}} = (p_1 \times p_2 \times \dots \times p_n) / (p_1 + p_2 + \dots + p_n)$$

35 The result is that, it is then possible to have a finer adaptation to the required power and then to reach a finer temperature at the exit of the machine. The

explanations will be given hereafter in relation with the figures and the example.

Concerning the electrical resistors according to the
5 first embodiment of the invention, in the case of a coffee machine, one to 5 resistors are present, in the case of a vending machine, it is possible to have 1 to 10 resistors. For the second embodiment of the device of the invention, in the case of a coffee machine, two to five
10 resistors are present, in the case of a vending machine, it is possible to have 1 to 10 electrical resistors. The resistors are either disposed on a tube or on a flat base.

15 The material for the hollow tube is a metal. Preferably, the tube is made of stainless steel. The size of the tube can vary, depending on the type of use. For example, if it is used for a coffee machine, it can have a diameter of about 6 to 20 mm and a length of about 100 to 200 mm.
20 The thickness of the tube is around 1 to 4 mm. In the case of a use in a vending machine, the tube has a diameter of about 30 to 50 mm and a length of about 200 to 400 mm. The thickness of the tube is the same as before.

25 The ratio of the length of the hollow tube to the diameter of said tube is comprised between about 5 and about 40.

30 The heating module according to the invention comprises further a cylindrical insert, which is disposed inside the hollow tube, along its entire length and substantially along its axis of symmetry. The fact that an insert is present enhances heat transfer from the tube surface to the liquid by increasing the water speed which increases the transfer coefficient. The best speed is when a turbulent flow is reached. This allows a good transfer of energy and a quick heating of the water. The
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insert is made of plastic, metal or ceramic material, which is food grade. The insert is preferably in a low thermal coefficient material such as plastic and especially teflon (tetra-fluoro-ethylene), but can also
5 be in another food grade material. The ratio of the diameter of the hollow tube to the diameter of the insert is comprised between 1 and 5. It is possible to have either a fixed insert or an insert, which can be rotated along its axis of symmetry. In the case of a rotating
10 insert, said insert is connected with a rotating wheel of a flowmeter disposed at the lower part of the insert and so it can be powered by the flowing cold water, which flows in a tangent angle on to the flowmeter propeller. The rotatable cylindrical insert comprises a metal wire brush. These metal brush bundles are integrated through
15 the insert in a longitudinal plane (on one side only or or two symmetric sides of the insert) or on a spiral way, for example 1 or 2 spirals. They are built only in the insert part inside the hollow tube. The brush should be
20 of proper mechanical tensile and strength so that it can descale the inner tube surface. Both the brush bundle ends should be slightly contacted with the inside surface of the tube at 90° . The whole bundles should be designed to push water upwards when it is powered to rotate by the
25 flowmeter propeller.

The insert can also be a hollow object, which will introduce a reversed flow of part of the hot water to mix with the cold water and so to enhance water mixing when
30 the water is heated.

The insert can also present helicoidal grooves on its outside surface : this is a good solution to oblige the liquid to flow into channels and reach a turbulent flow
35 and therefore favours a quick heating at the required temperature. Finally, it is possible to have a spring disposed around the insert.

In the case of the resistors disposed on a flat base, channels are inside a structure for the flowing of the liquid, said channels being positioned along the resistor tracks. In this case, it is either possible to have the resistors on only one side of the structure, or on both sides of the structure. The channels for the flowing of the liquid have a reduced section area, so that the speed of liquid reaches a turbulent flow.

10 The electrical resistors of the tube are made in a form selected from the group consisting of wires and thick-film. The thick-film technology is known in the electronic area and is now used for the manufacture of resistors. The technology uses conductive inks (like
15 paste) over a substrate of quartz, metal, alumina or beryllium oxide. As said before, it is preferably a metallic substrate.

20 The electrical resistors have a power density of up to 15 to 70 Watt/cm². This power density of the resistors allows a very quick increase of the temperature of the water from the room temperature to around 85-90 °C. In order to have a good electrical insulation of the hollow
25 tube, it is preferred to have an enamel painting on the outside of said tube under the resistors. The thickness of this painting is normally comprised between 100 and 300 microns. Finally, the electrical resistors of the hollow tube are covered with an electrically non conductive material, for example a layer of enamel
30 painting or a plastic. This insulation can be either a tube or a layer of a non conductive material.

35 The liquid heating module of the invention is used as a part of a machine for the heating of a liquid for the preparation of a beverage. The present invention concerns further a system for the heating of a liquid comprising - a liquid supply,

- a pump for supplying said liquid to
- a device for the heating of a liquid as described before, wherein said liquid flows from the liquid supply through a tube or channels in said system,
- 5 - a way for the exit of heated liquid, either on a substance to be extracted or in a mixer to mix said heated liquid with a powder.

According to a first embodiment, the liquid heating
10 module is part of a coffee machine or another similar machine based on the extraction of a substance, like coffee or tea. In this case, it is possible to have either directly the substance to be extracted, like a bed of coffee, and then an espresso machine, or the substance
15 to be extracted in already prepared cartridges or capsules, like those object of the European patents No. 512'468 and 602'203.

According to a second embodiment, the system of the
20 invention is used for vending machines, that is a machine where the consumer has directly the cup of tea, of coffee or of cocoa, wherein the heated liquid is mixed just before being delivered in a cup with the corresponding powder.

25 The system of the invention integrates also other usual elements present normally in coffee or vending machines, like a valve, a temperature control, a flowmeter.

30 The present invention concerns finally a process for the device described above, wherein the electricity power in resistors and/or set of resistors is controlled so as to provide to the liquid the required energy in real-time to reach the liquid target temperature according to the
35 energy balance based on the liquid flow-rate, on the power voltage, on the liquid inlet temperature, on the energy state of the machine and the target liquid temperature.

According to this process, the flow-rate is comprised between 50 and 300 ml/min for a coffee machine and between 300 and 5000 ml/min for a vending machine.

5

One of the advantage of the process of the invention is that, you do not need to have a power "on/off" position. In conventional machine, when you put the "on" position, the heater is under voltage and heats before you have any demand on a coffee extraction. According to the present invention, there is no more need on such a pre-heating. When a coffee is needed, you are already on the "on" position, but there is no heating of the corresponding resistors. When the consumer decides to prepare a coffee, the pump moves the water to flow in the tube at the level of the first resistor, the pump stops and the first resistor heats the water at a temperature around 72 °C. When the necessary energy to heat the amount of water under the first resistor has been delivered, the pump starts again and the water fills the tube at the level of the second resistor. Then, this second resistor heats the cold water coming from the first resistor at 72°C to around 80°C and in the same time, the first resistor heats the new cold water coming at ambient temperature to 72°C. The pump starts again and fills the tube to the level of the third resistor, then the second and third resistors are electrically linked in serial to heat the water to 86°C and the first resistor heats the new cold water from ambient temperature to 72°C. Then, the pump starts again and the water is heated continuously (without any pump stop) to extract the coffee in the cup. Depending on coffee, the procedure takes around 20 to 30 seconds. For the next coffee, the same procedure is repeated.

35

The invention is described in further detail in relation with an example.

Example

In this case, there are three resistors, R1= 750 W,
R2= 660 W and R3= 1300 W. We are here in the embodiment
5 of R1 alone, R2 can be alone or in serial with R3. This
means , that you can have following power output
possibilities :

	R1	750 W
10	R2	660 W
	R1 R2	1410 W
	R2 + R3	438 W
	R1,R2+R3	1188 W

15 The calculation has been made according to the above
mentioned formula. As clearly shown in this table, it is
not possible according to the invention to have the
addition of the 3 resistors, this means that you have a
fine adaptation of the temperature without a big power
20 demand. The tube is a stainless hollow tube having a
diameter of 20 mm with a length of 170 mm. The insert is
made of Teflon and has a diameter of 16 mm and the same
length as the hollow tube. The water flows with a flow
rate of 50 to 200 ml/min. The required temperature is
25 reached within 4 sec.

The invention is described in further detail in relation
with the drawings, wherein :

30. Fig. 1 is a schematic view of the device for the heating
of a liquid in a coffee machine for the extraction of
closed cartridges according to example 1,

Fig. 2 is a schematic view of the device for the heating
35 in the first embodiment,

Fig. 3 is an enlarged schematic view of figure 2 and

Fig. 4 is a schematic view of the device for the heating in the second embodiment.

According to figure 1, the coffee machine comprises a
5 cold water tank (1) connected through a pipe (2) to a
flow-meter (3) and a pump (4) delivering the cold water
to the device (5) for the heating of the water. The
device (5) is in 3 parts : a first resistor R1 alone and
both resistors R2 and R3, which are linked in serial. The
10 connection of these resistors to the power occurs through
(6,7). At the exit of the device (5), the hot water flows
through a conduit (8) and arrives through (11) on a
cartridge (9) containing roast and ground coffee. This
cartridge is a sealed cartridge opening under pressure
15 according to the EP patent No. 512'468. The ready to
drink coffee flows in a cup (10). The coffee machine
comprises further a cold water temperature sensor (12), a
hot water temperature sensor (13) and also sensors (14)
and (15) disposed between R1,R2 respectively R2,R3. It is
20 also possible according to the invention to have at the
exit of the heating device a conduit (16) for the
production of steam. On the electrical circuit, the
presence of the switches S1, S2 and S3 are essential for
the operation of the coffee machine.
25

The coffee machine operates as follows : The consumer
puts a cartridge (9) and starts the machine. The pump (4)
moves the cold water from the tank (1) through the pipe
(2) so that the water reaches the level of R1 and the
30 pump stops. At this time, only switch S1 is closed, R1 is
under voltage and the water is heated at a temperature
around 72 °C. When the necessary energy has been
transferred from the first resistor to the water (by the
energy balance calculation), the pump operates again and
35 moves the water at the level of R2, the pump stops again
and switches S1 and S2 are closed. When the necessary
energy to heat the water under the second has been
transferred by said second resistor to reach around 80 °C

and the necessary energy to heat the water under the
first resistor has transferred by the first resistor to
reach 72 °C, the pump operates again and moves the water
at the level of the third resistor. Then, switches S1
5 and S3 are closed and S2 opened, so that the three
resistors can transfer energy to the water to heat the
water at the exit of the device around 86 °C. The pump
and heating operate continuously, so that the hot water
is brought to the head of extraction. Based on the liquid
10 flow-rate, the power voltage and the liquid inlet
temperature, the heat energy generated is adjusted in
real-time to allow the liquid to be heated to reach the
target temperature.

15 Fig. 2 and 3 gives a closer view of the heater in the
form of a tube. The heater (20) presents a water inlet
(21) and a water outlet (22). An insert (23) is inside of
the tube and present on its outside helicoidal grooves
(25) : the water is therefore forced through the way
20 (26). On the outside (24) of the tube, the resistors R1 ,
R2 and R3 (not shown) are present and allows a heating of
the water according to the process just described above.

25 Figure 4 shows the heater (30) in a flat form. There is a
water inlet (31) and a water outlet (32). The water flows
through the channels (33). According to this embodiment,
it is possible to have 1 to 5 resistors (not shown) on
one or both faces of the heater.

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Claims

- 1) A device for the heating of a liquid in a beverage machine comprising
 - at least one set of at least two resistors, wherein said resistors are electrically linked together so as to use one resistor of each set individually or in serial with one or more of the resistors of the same set
 - at least one individual resistor and at least one set of at least two resistors, wherein said resistors are electrically linked together so as to use the first resistor of a set individually or in serial with one or more of the following resistors of the same set, said resistors transferring the maximum of energy to the flow of liquid and allowing a finer control of the liquid temperature.
- 2) A device according to claim 1, wherein the system of resistors is disposed on a tube, the liquid flowing in said tube.
- 3) A device according to claim 2, wherein it comprises further a cylindrical insert, which is disposed inside the tube, along its entire length and substantially along its axis of symmetry.
- 4) A device according to any of claims 2 or 3, wherein the insert comprises helicoidal grooves on its outside surface.
- 5) A device according to any of claims 2 to 4, wherein a spring is disposed around the insert.
- 6) A device according to any of claims 2 to 5, wherein the ratio of the length to the diameter of the tube is comprised between about 5 and about 40.

7) A device according to any of claims 3 to 5, wherein the insert is an insulated material, taken from the group consisting of plastic, metal and ceramic.

5
8) A device according to any of claims 3, 4 or 7, wherein the insert is fixed or can be rotated along its axis of symmetry.

10 9) A device according to any of claims 3 to 8, wherein the insert is rotated because of its connection with a rotating wheel of a flowmeter disposed at the lower part of said insert.

15 10) A device according to claim 9, wherein the rotatable cylindrical insert comprises a wire brush.

11) A device according to claim 1, wherein the system of resistors is disposed on a flat base, liquid flowing through channels, which are positioned along the resistor tracks.

20
25 12) A device according to claim 11, wherein the channels for the flowing of the liquid have a reduced section area, so that the liquid flow reaches a turbulent flow.

30
35 13) A device according to any of claims 1 to 12, wherein the different electrical resistors are made in a form selected from the group consisting of wires, thick-film resistors.

14) A device according to any of claims 1 to 13, wherein all the electrical resistors have a power density of up to 15 to 70 Watt/cm².

15) A device according to any of claim 2, wherein the hollow tube comprises enamel painting on its outside under the resistors.

16) A device according to any of claims 1 to 15, wherein
the electrical resistors are covered or insulated with
an electrically non conductive material.

5

17) A system for the heating of a liquid comprising
- a liquid supply,
- a pump for supplying said liquid to
- a device for heating a liquid according to any of
10 claims 1 to 16, wherein said liquid flows from the
water supply through a tube or channels in said system,
- a way for the exit of heated liquid, either on a
substance to be extracted or in a mixer to mix said
heated liquid with a powder.

15

18) A process for heating the system according to claim
17, wherein the electricity power in resistors and/or set
of resistors is controlled so as to provide to the liquid
the required energy in real-time to reach the liquid
20 target temperature according to the energy balance based
on the liquid flow-rate, on the power voltage, on the
liquid inlet temperature, on the energy state of the
machine and the target liquid temperature.

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19) A process according to claim 18, wherein the flow-rate
is comprised between 50 and 300 ml/min for a coffee
machine and between 300 and 5000 ml/min for a vending
machine.

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Abstract

A device for the heating of a liquid.

5 The present invention concerns a device for the heating of a liquid in a beverage machine comprising

- at least one set of at least two resistors, wherein said resistors are electrically linked together so as to use one resistor of each set individually or in serial with one or more of the resistors of the same set
- at least one individual resistor and at least one set of at least two resistors, wherein said resistors are electrically linked together so as to use the first resistor of a set individually or in serial with one or more of the following resistors of the same set, said resistors transferring the maximum of energy to the flow of liquid and allowing a finer control of the liquid temperature.

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Fig. 2

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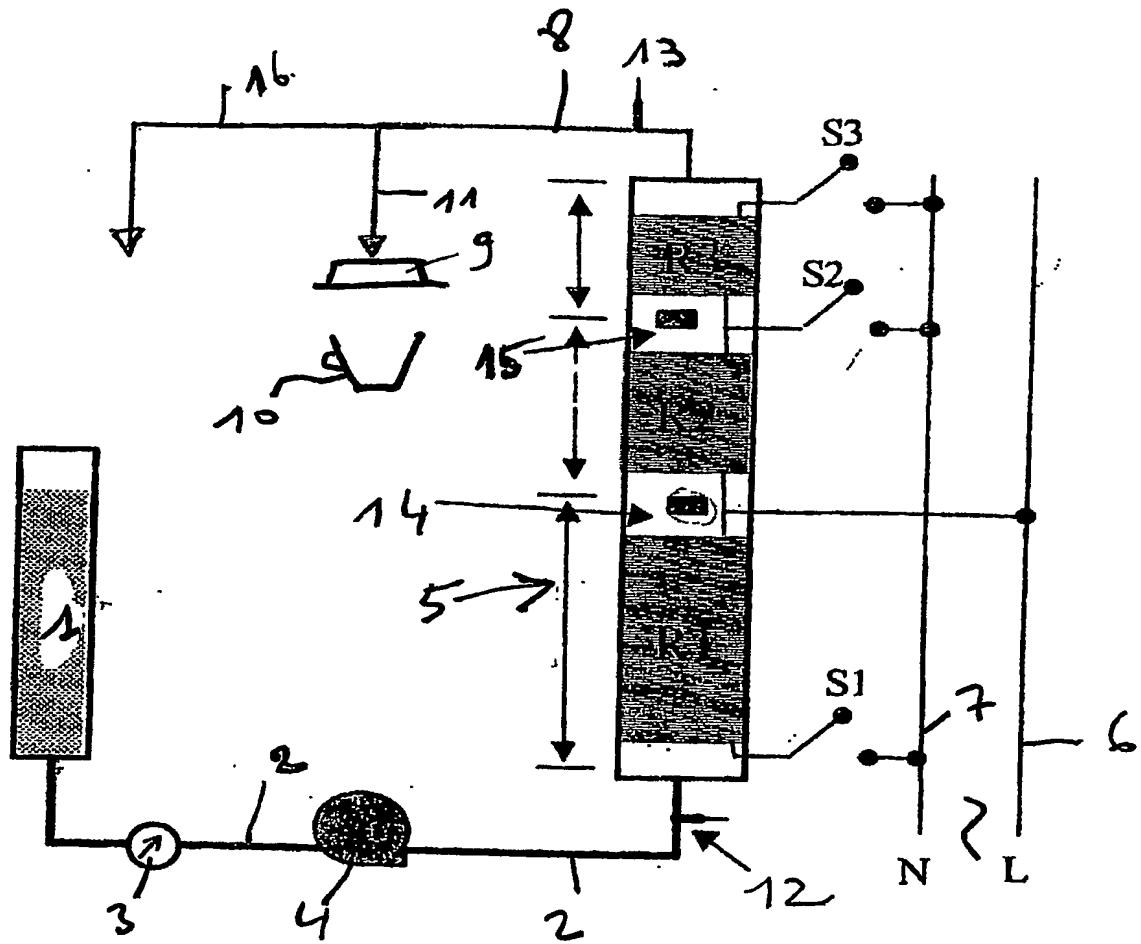
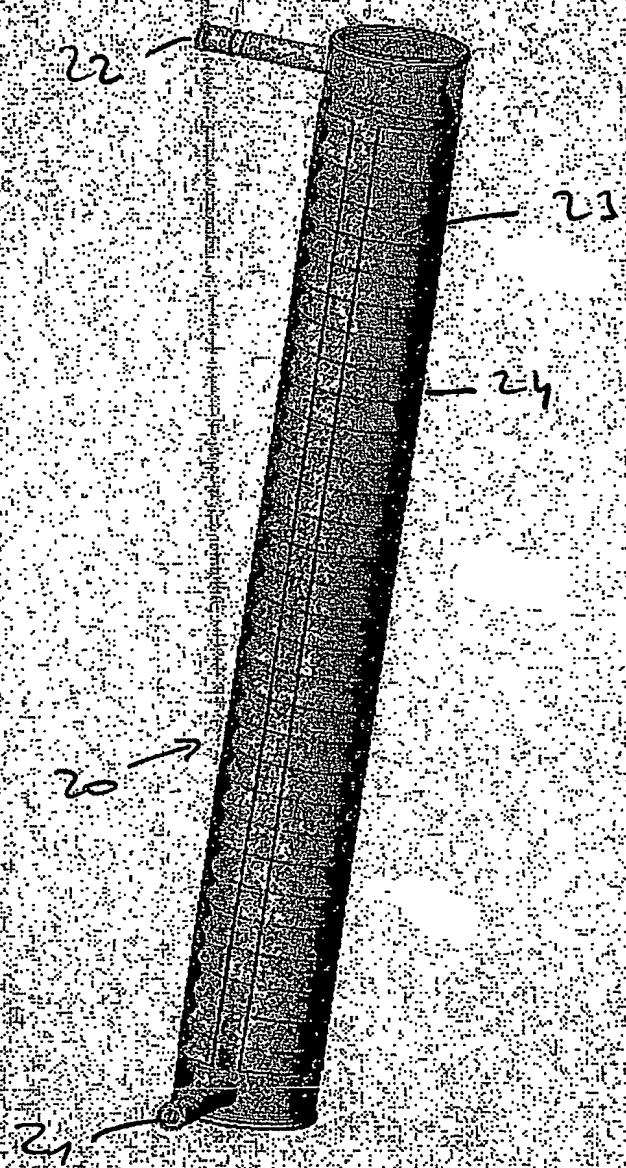


FIG. 1



F I G . 2

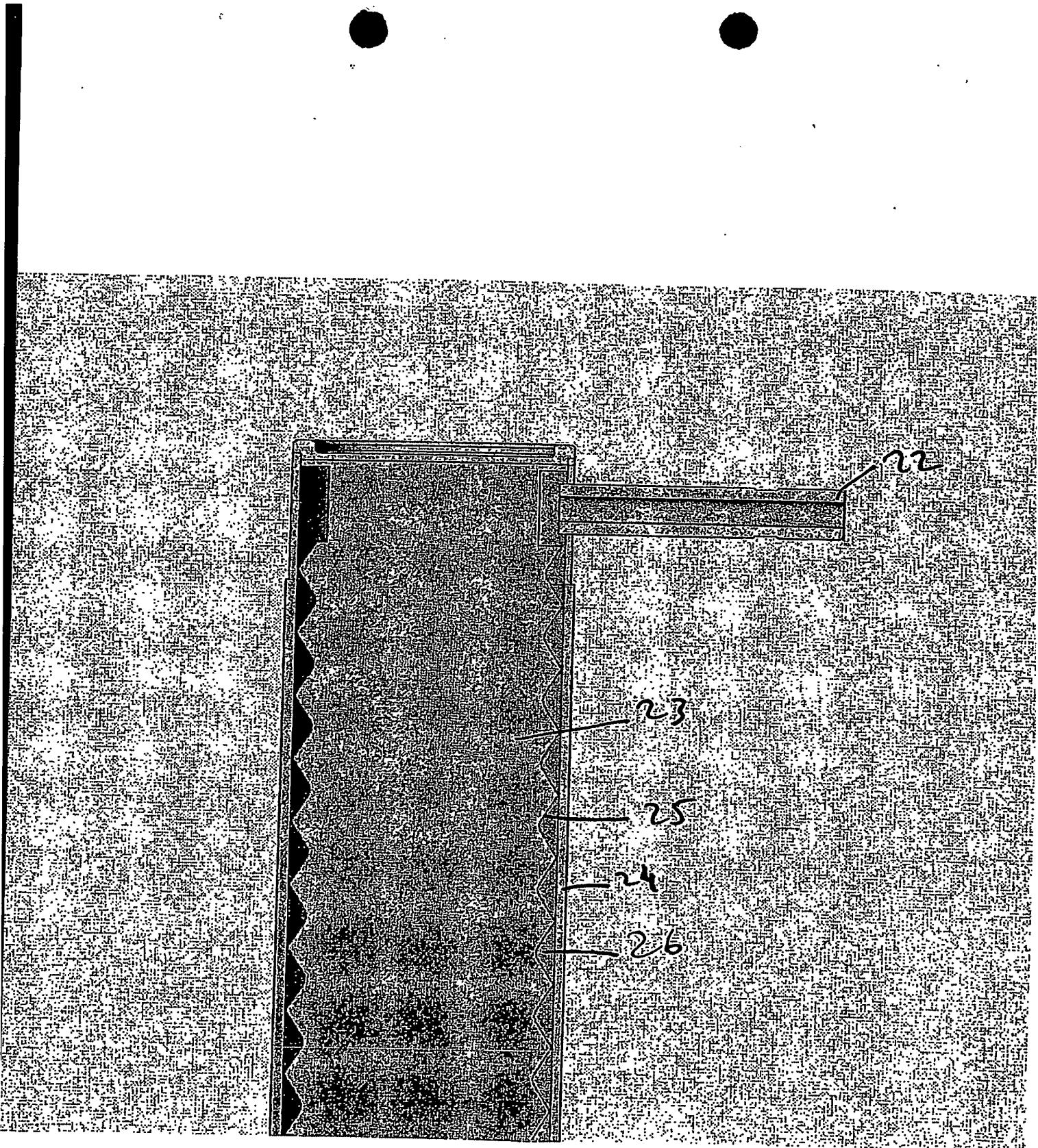


FIG. 3

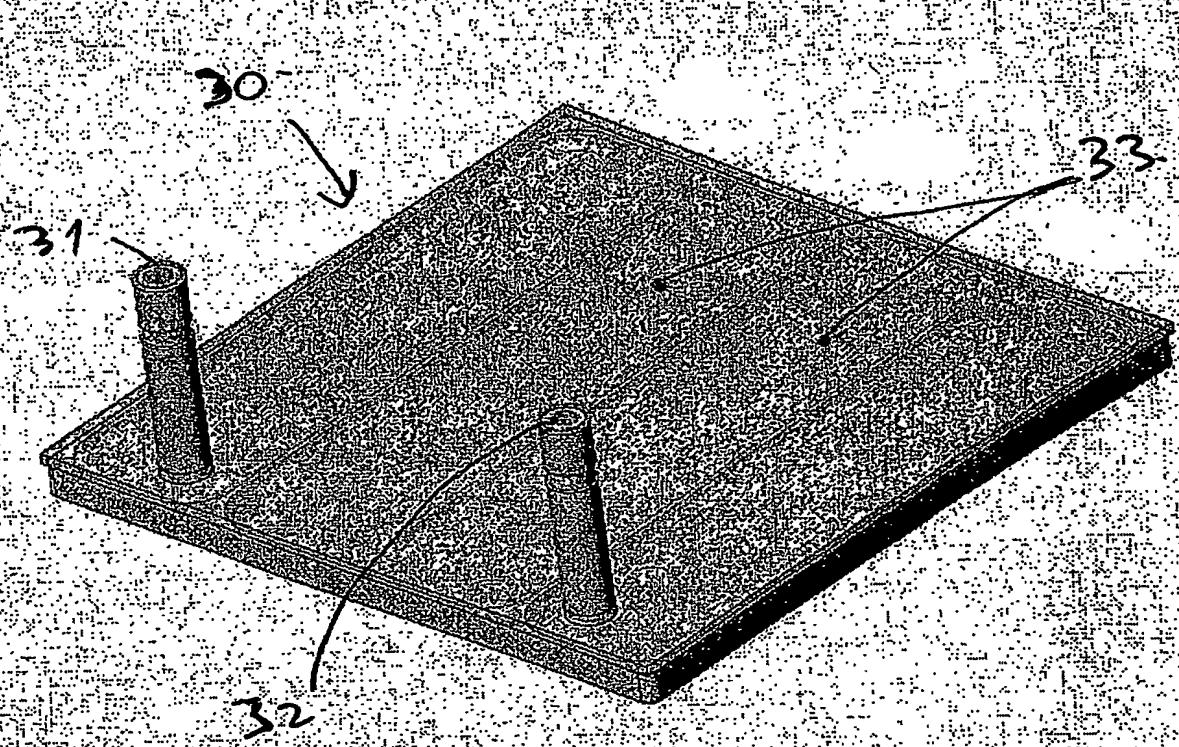


FIG. 4.

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